8.Planetary Motion and Gravity

Edexcel GCSE Astronomy Course

Topic specification summary:

8.1 Understand the contribution of the observational work of Brahe in the transition from a geocentric to a heliocentric model of the Solar System

8.2 Understand the contribution of the mathematical modelling of Copernicus and Kepler in the transition from a geocentric to a heliocentric model of the Solar System

8.3 Understand the role of gravity in creating stable elliptical orbits

8.4 Understand Kepler's laws of planetary motion

8.5 Understand the terms 'aphelion' and 'perihelion' (solar orbits), 'apogee' and 'perigee' (Earth orbits) for an elliptical orbit

8.6 Be able to use Kepler's third law in the form:

$$T^2/r^3 = \text{a constant}$$

where T is the orbital period of an orbiting body and r is the mean radius of its orbit

8.7 Understand that the constant in Kepler's third law depends inversely on the mass of the central body

8.8 Know that Newton was able to explain Kepler's laws using his law of universal gravitation

8.9 Understand that the gravitational force between two bodies is proportional to the product of their masses and inversely proportional to the square of their separation (algebraic expression of Newton's law of universal gravitation not required)

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These are all conceptual ideas that helped in the development of revolutionary ideas in science as the Middle Ages ended and the Renaissance period began in the 16th century.

Review the history of the ideas and the people associated with them here:

https://earthobservatory.nasa.gov/features/OrbitsHistory

8.5 Understand the terms 'aphelion' and 'perihelion' (solar orbits), 'apogee' and 'perigee' (Earth orbits) for an elliptical orbit

See the diagrams at these links:

https://www.timeanddate.com/astronomy/perihelion-aphelion-solstice.html

https://www.timeanddate.com/astronomy/moon/lunar-perigee-apogee.html

You need to remember which is which:

'Helion' refers to the Sun just like Heliocentric etc

'Gee' refers to the Earth

One way to remember is that 'peri' starts the word 'perilous' as in 'perilously close' - or you may want to make up an 'aide memoire' of your own!

Kepler's Third Law

8.6 Be able to use Kepler's third law in the form:

$$T^2/r^3 = \text{a constant}$$

where T is the orbital period of an orbiting body and r is the mean radius of its orbit

Start by plotting a graph of orbital radius vs orbital period for the planets - you will not be able to plot all of them sensibly as the numbers become very large.
Mercury to Jupiter should work on the same scale:
https://nssdc.gsfc.nasa.gov/planetary/factsheet/
Then try a graph of T^2 **vs** r^3 **- note the difference between the shape of the line in each graph**

(Using a spreadsheet to do this will make the tasks much easier than hand drawing the graphs…)

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Watch this great video - keep the link safe and maybe even screenshot some of the frames to put in your notes:

https://www.youtube.com/watch?v=KbXVpdlmYZo&ab_channel=Socratica